Research Paper | Computer Science | E-ISSN No : 2454-9916 | Volume : 2 | Issue : 11 | Nov 2016

AN OVERVIEW OF A PERVASIVE AND PERSONALIZED SMART HEALTH-CARE SYSTEM USING IOT

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ABSTRACT

In the last few years, the convincing forward steps in the development of Internet-of-Things (IoT) enabling solutions are spurring the advent of novel and fascinating applications. Among others, mainly Near Field Communication(NFC), Wireless Sensor Network (WSN), Image Processing and smart mobile technologies are leading this evolutionary trend.

In the system a novel idea of IoT based, smart architecture for automatic monitoring and tracking of patient's personnel, and biomedical conditions within hospitals and nursing institutes is proposed. Staying true to the IoT vision, we propose a Pervasive and Personalized Smart Health-Care System (PPSHS) which relies on different, yet complementary, technologies, specifically NFC, WSN, Image Processing for Motion Detection using smart mobile devices, inter-operating with each other through a CoAP/NFC/SOAP network infrastructure.

The PPSHS is able to collect, in real time, both environmental conditions and patient's physiological parameters via an Hybrid Sensing Network (HSN) composed of nodes integrating NFC and WSN functionalities. Sensed data are delivered to a control center where an advanced monitoring application in cloud makes them easily accessible to both local and remote users via a SOAP web service.

KEYWORDS: Health Care, Smart Environment, Hybrid Network, Internet Of Things(IOT), Near Field Communication(NFC), Wireless Sensor Network(WSN), Image Processing (Motion Detection), Simple Object Access Protocol(SOAP), Constrained Application Protocol(CoAP), Cloud Data Storage and Analytic.

I. INTRODUCTION

The healthcare management is mostly done by the doctors and the nursing staff, which often may lead to errors and failure of devices.

In India, the monitoring of patients and nursing staff is done manually. This leads to many technical and non-technical difficulties. The data provided might be inaccurate and also everything can't be put up in paper format. Digitization in modern age has entirely changed the outlook of human life. We can do things now that were imagined to be impossible. This digitization can make the healthcare system into Smart Healthcare System. This will provide us to monitor patient's health in real time as well as tackle the shortage of nursing staff problem.

The main motivation behind developing a smart healthcare system is, to make the healthcare efficient and low cost, and also to take care of the patients and diagnose them properly. Thus the idea of the project is to create an IOT based smart health-care system, which is able to collect, in real time, both environmental conditions and patient's physiological parameters.

Near field Communication (NFC), Wireless Sensor Network (WSN), Image Processing for motion detection and smart mobile represent some of the most promising technologies enabling the implementation of smart healthcare systems.

NFC is a low-cost, low-power technology which can be used to tag patients and collect the parameters of patients on a NFC enabled smart device such as smart phone or tablets, which enables staff to gather accurate readings of patients without manually writing it down. This tags can be reused over different patients by reprogramming them after use, this very effectively cuts the cost of tagging patients with static devices such as RFID tags which cannot be programmed.

WSNs on other hand are basically self-organizing ad-hoc networks of small, cost-effective devices that communicate in a multi-hop manner to provide observe and control functionalities in critical applications including industrial, military, home, automotive, and healthcare scenarios. Currently, most WSN are battery powered computing platforms integrating analog/digital sensors and an IEEE 802.15.4 radio enabling up to 100-m outdoor communication range (single hop).

Integrating NFC, WSN, Image Processing (motion detection) with sensors such as temperature, heartbeat, blood pressure, blood sugar, etc., can create a very efficient Hybrid Sensing Network (HSN) system of monitoring patient's physiological parameters as well as environmental parameters inside hospital and nursing homes.

Basing on this concept, the IoT system of Pervasive and Personalized Smart Health-Care System (PPSHS) proposed will be accessible through internet, to doctors, patients, nursing staffs with required data through Simple Object Access Protocol (SOAP). Data stored over a cloud system can be further used in analysis of pattern of diseases, improvement in management, analysis of drug dose to patients, etc.

The proposed system is also able to manage emergency situations in real time. In fact, in this case, the WSN-based transmission is activated so as to promptly inform the nursing staff via Push Notifications on a customized mobile application. Doctors can also connect their smartphone which are NFC enabled reader and use the same mobile application to interact with patients' nodes during daily medical inspections.

II. RELATED WORK

"Equipment Location in Hospitals Using RFID-Based Positioning System"[1] was proposed by Ali Asghar Nazari Shirehjini, Abdul salam Yassine in 2012, which used RFID-based system for mobile object positioning in hospitals, this system was limited only up to monitoring of medical devices in hospitlas and nursing homes.

A survey was undertaken by Luca Mainetti, Luigi Patrono in 2012 to understand the evolution of WSN towards IoT in which devices where connected to each other through WSN.

"NIGHT-Care: a passive RFID system for remote monitoring and control of overnight living environment "[2] system by Cecilia Occhiuzzi, Carmen Vallese in 2014 proposed Combination of wearable tags and ambient tags a-fully passive RFID system to remote monitoring the state of children, disabled and elderly people during the night, this system mainly focused on child and elderly care using wearable tags and RFID.

"An IoT-Aware Architecture for Smart Health-care Systems"[3] was proposed by Luca Catarinucci, Danilo De Donno in 2015 which used RFID and WSN in hospitals for monitoring patients.

The systems here use RFID tags to tag patients and devices which need to be carried over patient's body, that can cause discomfort in some situations, as well as RFID tags cannot be programmed thus limiting their use in large numbers if cost efficiency of system is considered.

The proposed system makes use of NFC's (Near Field Communication) tags and WSN (Wireless sensor Networks) to read the patient's health details and store it onto the database via the servers. The NFC's are writable, hence unlike RFID can be reused. Using these tags, patient's physiological details like heartbeats, temperature, level, can be measured and then the data is transferred using the bluetooth controller to the android device placed near the patient. The device reads the data and then sends it to the server over the internet. The devices are interconnected together to form an Internet-of-things (IOT). Use of IOT makes it easier to manage real time data monitoring.

This system guarantees the real time monitoring of patient's health. The designed SHS (Smart Hospital System) is able to collect, in real time, both environmental

conditions and patients' physiological parameters. NFC sensing in healthcare enables zero-power, low-cost, and easy to- implement monitoring and transmission of data.

III. SYSTEM OVERVIEW

This work aims at designing and implementing an IoT aware Pervasive and Personalized Smart Health-Care System (PPSHS) having, as main peculiarity, the capability to readily combine different, yet complementary, technologies enabling novel functionalities. Basically, the system we propose should be able to collect, in real time, both environmental conditions and patients' physiological parameters and deliver them to a control centre. At this point, an advanced monitoring application should analyse the received data and send alert messages in case of emergency. The conceived PPSHS will been put into effect according to the architecture illustrated in Fig. 1.

As shown in Fig. 1. It is composed of four main parts:

(1) A microcontroller integrated real time sensor system create a Hybrid Sensing Network (HSN) to monitor patient's physiological parameters.

(2) A cloud based administrator application system and database system using), Constrained Application Protocol (CoAP) for patient registration and storing sensor information logs, alerts etc.

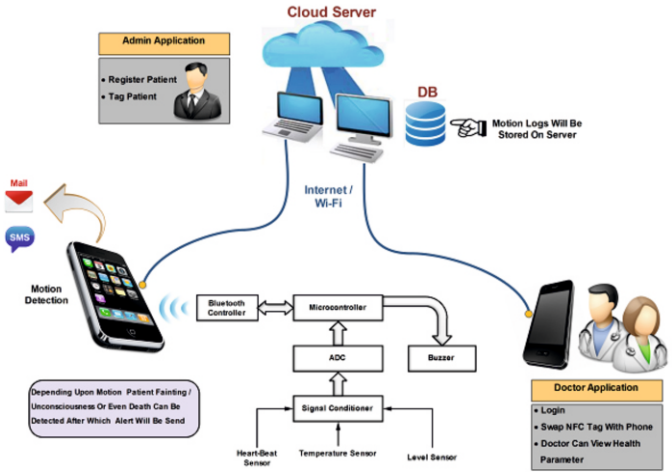

Fig. 1. Overview of the Pervasive and Personalised Smart Hospital System (PPSHS)

(3) A Bluetooth controlled response and alert system which will be enabled only in emergency situations like fainting, unconsciousness.

(4) Doctor and nursing staff mobile device application using Simple Object Access Protocol (SOAP) to view health parameters with NFC enabled devices.

As shown in figure, the main database is stored over the cloud using the server PC. The server PC will also provide online registration of patients. The patient's will receive their tags as per the registration.

The hardware part consists of the microcontroller attached to the ADC (analog to digital converter) and signal conditioning to convert received data into digital form for transmission. The sensors - heartbeat sensor, level sensor and temperature sensor are attached to the microcontroller. These sensors can also be increased as required. There is also a bluetooth controller which is used to transfer the data to the patient's smartphone which will then transfer the data to the server via the internet or Wi-Fi. The staff can tap the NFC card with the smartphone to get all the health details of the patient. The patient's app also contains motion detection using accelerometer to keep track of patient's movements.

The doctor's app contains a login page. The doctors have to login into the system using their username and password. This provides security for the system. Doctor can check the patient's physiological parameters in real time using the app. Using accelerometer, the patient's actions such as fainting, falling, having an attack, can be detected and the emergency alarm will be sent accordingly. The alarm will be both in message or email format or a popup dialogue box on the doctor's smartphone. Also, a buzzer is provided near the patient which will go on in case of emergency.

The sensed parameters are transferred to a control centre where they are made easily accessible by both local and remote users via a customized web service. The system is designed by keeping in mind two scenarios, one is the real time monitoring of patients and the second one the emergency situations. By receiving alarm as a popup dialogue box directly to the doctor, lot of time will be saved and it may even save the patient's life. The emergency cases can be detected by the motion detection accelerometer kept beside the patient. The system will provide power-effective remote patient monitoring and immediate handling of emergencies.

III. GOALS AND OBJECTIVES

- To deliver transparent and quality care to patients while reducing the healthcare cost and tackling the nursing staff shortage problem by using smart patient monitoring, care, management and supervision system.
- We tend to achieve real time monitoring of patient's physiological parameters for early detection of clinical deterioration.

IV. APPLICATIONS

Application of this system extend from smart healthcare system to home based health care.

This system can be easily extended to Smart Hospital Management System which will not only monitor patients with less human interaction but will also cover staff management, resource management, and energy efficiency.

V. SUMMARY AND CONCLUSION

An IoT-aware, Smart Hospital System (SHS) architecture for automatic monitoring and tracking of patients, personnel, and biomedical devices within hospitals and nursing institutes has been proposed. With a vision of making a better hospital environment not only for patients but also the nursing staff and doctors can be developed which may entirely change the course of India's current Healthcare system. This system is designed, keeping in mind of the India's goal of making Smart cities. Smart cities are not possible without smart hospitals. Hence, the solution to current Smart city crisis may start from building a smart Healthcare system. The proposed system will definitely help in building a better Healthcare System in India.

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